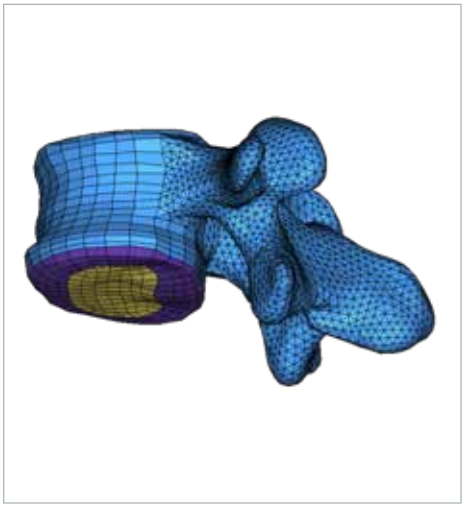
Solid Hex Meshing the Human Lumbar Spine



NUVASIVE
Speed of Innovation®

Key Highlights

Industry
Healthcare

Challenge
Predict how a device will perform while ensuring they are safe and effective, before a single prototype is built.

Altair Solution
Pre-processing with HyperMesh

Benefits
- Over 65% reduction in simulation times
- Accurate Analysis
- Efficient Process

Computational modeling and simulation, which uses computer-based mathematical techniques, is on the verge of revolutionizing the field of medical devices. Modeling techniques allow computer models to eliminate bad ideas and refine the good ones long before they leave the drawing board. The computer models essentially anticipate the performance of cutting-edge medical devices for usage in various patient groups, ensuring that they are safe, effective, and can reach physicians and patients as quickly as possible. As the technology progresses, eventually, physicians may even be able to use computer models in personalized medicine, using imaging data to test a device on a virtual patient before it's implanted.

NuVasive Inc., based in San Diego, California, is a medical device company focused on the design, development and marketing of products for the surgical treatment of spine disorders. Ranking no. 3 in the US spine industry, they specialize in minimally disruptive surgical procedures and are the pioneers of lateral access spine surgery with eXtreme Lateral Interbody Fusion (XLIF®). Through innovative technological advancements, NuVasive has successfully progressed major spine surgery to where many patients have experienced extraordinary results—they are often walking the same day of surgery, experiencing reduced blood loss, spending less time in the hospital, and being able to return to work within four to six weeks (versus the traditional six months).

Keywords: Meshing, Morphing, Spine, FEA, Medical Device, Stress

NuVasive Success Story

"HyperMesh helped us reduce model development and simulation time, allowing us to execute more studies that are focused on improving patient outcomes."

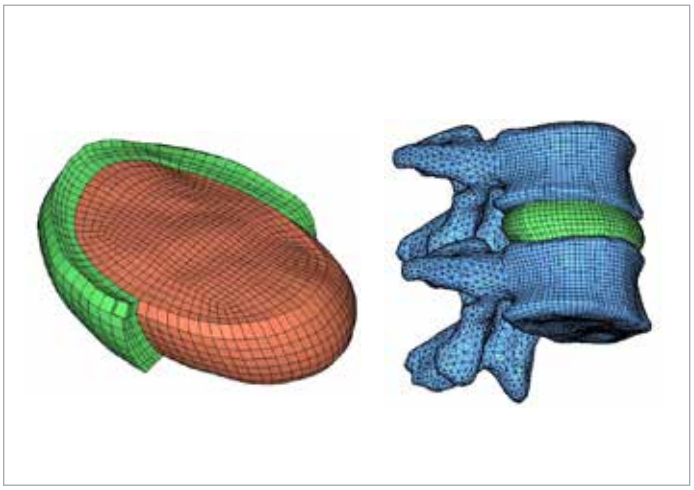
Jeff Harris Senior Engineer,
Computational Biomechanics,
NuVasive, Inc.

Correlation of Expensive Physical Testing

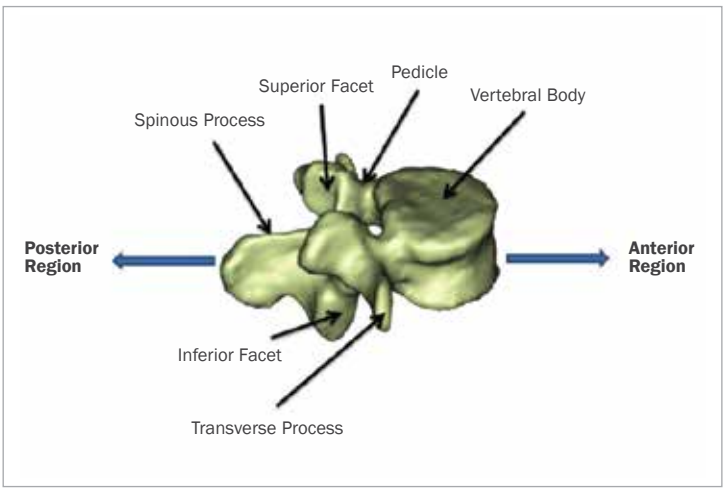
Computer modeling within the medical device industry is advantageous because it eliminates specimen variability, reduces testing time, and allows for the evaluation of designs under the same anatomical conditions. The objective of this project was to take anatomic geometry obtained from a CT scan and develop a finite element model that could evaluate the biomechanical stability of different interbody cage footprints that is typically performed using cadaveric testing. Since bone geometry is unique to each individual, and bones are not symmetric, a manual hexahedral (HEXA) meshing approach needed to be established in order to build models with a repeatable process.

Pre-processing with HyperMesh

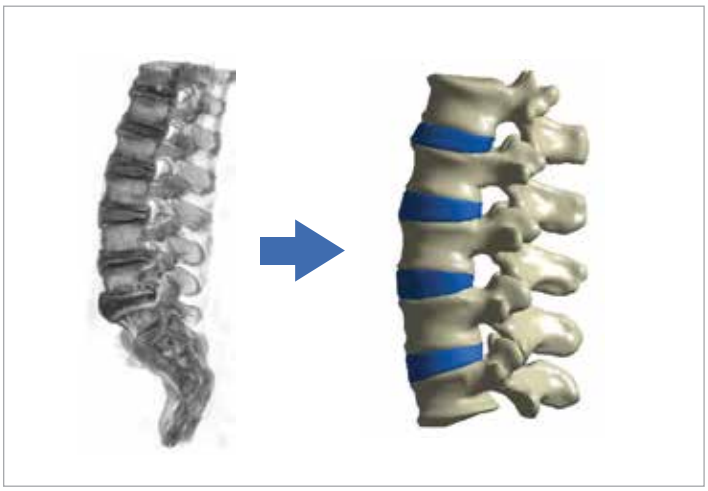
The vertebral bodies of the lumbar spine needed to be hex meshed and seamlessly connected to the posterior region using tetra elements. This would allow for a uniform mesh between the vertebral bodies and the intervertebral discs. Creating hex elements instead of standand tetra elements in the intervertebral body and discs allowed quicker run times. NuVasive looked at different software options in the market that could help them build such a model quickly and efficiently. With the solid meshing capabilities of HyperMesh and its powerful morphing tool they were able to quickly model the lumbar, while satisfying their analysis requirements.



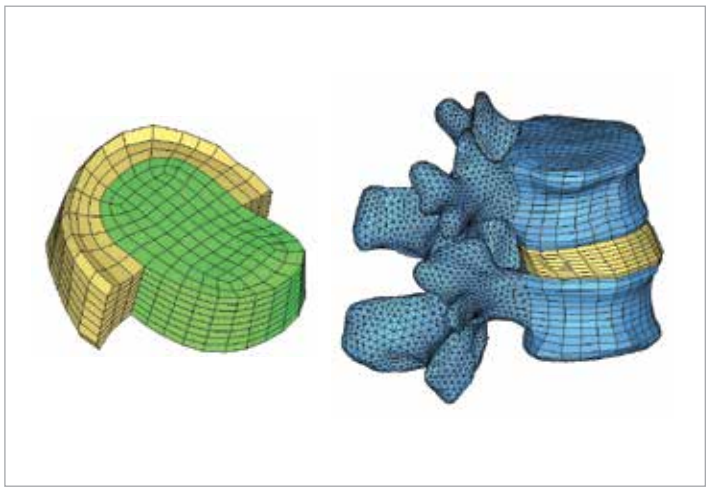
Using Morphing to add any needed shaping



Complex Geometry requires a robust meshing tool



CT Scan produces virtual slices from many different angles



Morphing and mesh generation

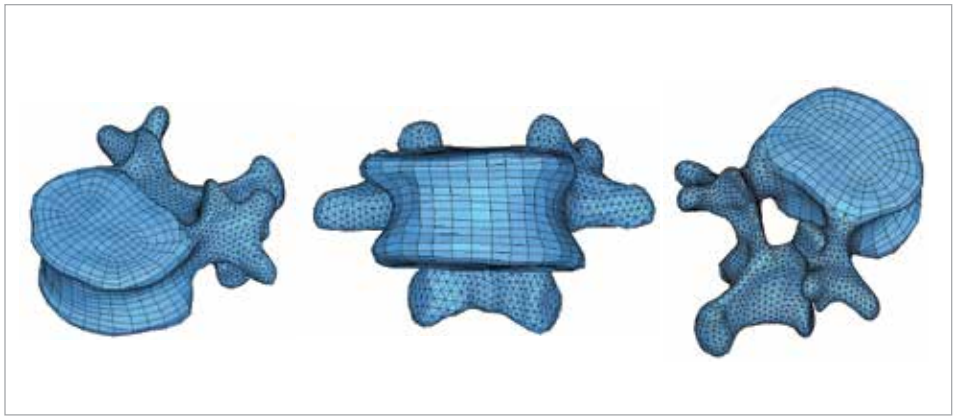
"HyperMesh allowed me to quickly create high quality models that can evaluate the biomechanics of the human lumbar spine", said Jeff Harris, Senior Engineer, Computational Biomechanics at NuVasive, Inc. The manual HEXA meshing approach process included the use of HyperMorph module to project elements onto geometry in exact areas. In addition, the geometry needed to be partitioned specifically to flow the HEXA elements together so as not to create mismatched element sizes and aspect ratios. Although this process was created from standard lines, project, and ruled meshing tools, it took advantage of HyperMorph functionalities where they could change the mesh patterns to match any new shape. This was a customized process using the existing tools in HyperMesh to fit the customer's needs in this unique application.

Lead Time reduction using HM for Complex Meshing

NuVasive's use of HyperMesh to HEXA mesh human vertebrae is now routinely used within their structural simulation department. They are currently using computational modeling using HyperMesh to anticipate the performance of medical devices when they are used in various patient groups.

By providing these new finite element analysis (FEA) models to device engineers, they are ensuring cutting-edge devices are safe and effective, and that they can reach the physicians and patients as quickly as possible.

The typical run times of simulation have been reduced from almost 12 hrs to only 4 hrs due to the effective modeling in HyperMesh. This also helps them internally to predict the biomechanical behavior and stability of the lumbar spine model. They are also able to effectively predict stresses induced in human lumbar spine with the introduction of meshed implants which gives them an overall understanding of the system. With the current modeling process, NuVasive is able to streamline the model more efficiently with shorter run times, pair up multiple designs quickly and check for stability of implants. "HyperMesh helped us reduce model development and simulation time, allowing us to execute more studies that are focused on improving patient outcomes" concludes Harris.



Images of one vertebra hybrid meshed

Visit the HyperWorks library of

Success Stories

at www.altairhyperworks.com

About Altair

Altair is focused on the development and broad application of simulation technology to synthesize and optimize designs, processes and decisions for improved business performance. Privately held with more than 2,600 employees, Altair is headquartered in Troy, Michigan, USA and operates more than 45 offices throughout 24 countries. Today, Altair serves more than 5,000 corporate clients across broad industry segments. To learn more, please visit www.altair.com.

About HyperWorks®

Performance Simulation Technology

HyperWorks is an enterprise simulation solution for rapid design exploration and decision-making. As one of the most comprehensive, open-architecture CAE solutions in the industry, HyperWorks includes best-in-class modeling, analysis, visualization and data management solutions for linear, nonlinear, structural optimization, fluid-structure interaction, and multi-body dynamics applications.

www.altairhyperworks.com

Altair Engineering, Inc., World Headquarters: 1820 E. Big Beaver Rd., Troy, MI 48083-2031 USA
Phone: +1.248.614.2400 • Fax: +1.248.614.2411 • www.altair.com • info@altair.com