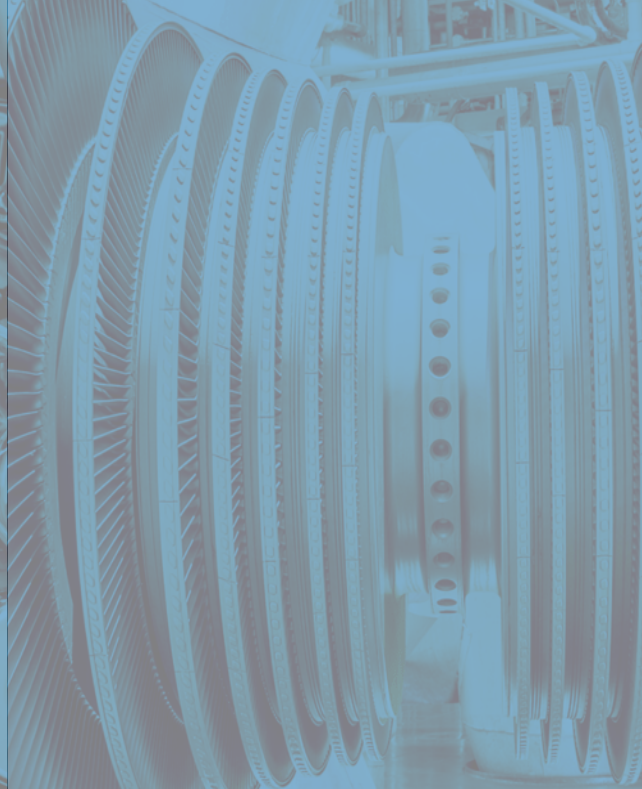
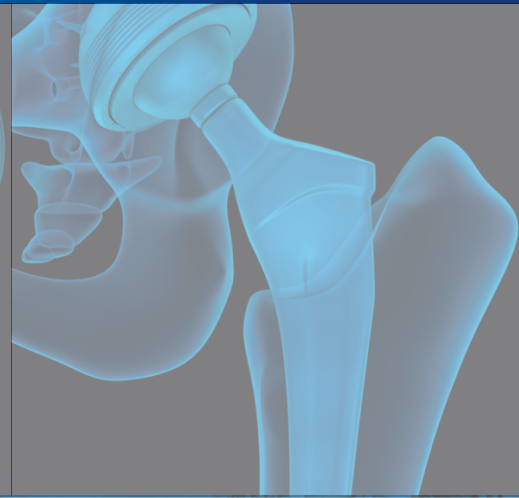
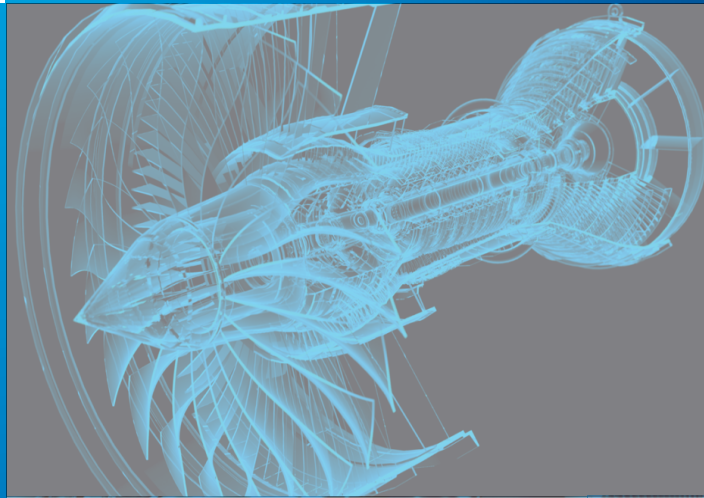




ThirdWave

Bold innovation in motion™

Material Modeling driven  
CAE solutions for  
companies that machine



**THIRD WAVE  
SYSTEMS**

## LEADERSHIP STATEMENT

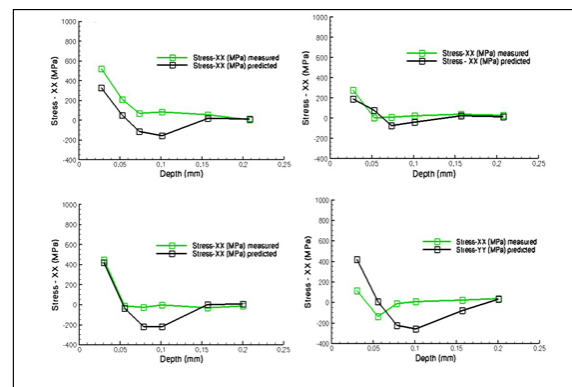
At Third Wave Systems (TWS), we pride ourselves on being the premier Computer-Aided Engineering (CAE) provider for companies that machine. Our modeling products and services are used by progressive companies, to dramatically reduce costs of machined components, accelerate design cycles, improve part quality, and get to market faster. Our experimentally validated material modeling technology, coupled with advanced Explicit-Dynamic Finite Element Analysis (FEA), gives engineers and other users vastly more information than trial-and-error testing alone. This enables them to make better decisions. Our talented team of engineers are passionate about materials, machining, modeling, and helping support Bold Innovation. This winning formula gives leadership at our customers the peace of mind that their people have the technology and support, to help drive their top and bottom lines.

## CORE COMPETENCIES

TWS' products are the only FEM-based, experimentally validated CAE products that analyze the material behavior at the tool cutting edge and at the toolpath level. They are easy to use because they are designed for people who understand machining, by people who understand it themselves. Here's what you'll find "under the hood" of these products:

- Advanced constitutive material models for accurate machining modeling
- Explicit-dynamic FEM solver to model complex mechanics
- FEM-driven toolpath modeling to provide more than just cutting forces
- Advanced algorithms to simplify analysis
- Open architecture to enable end-to-end analysis automation

Third Wave Systems has an expanding library of around 150 materials that have been developed and validated by Third Wave Systems engineering staff using proprietary material characterization technology that our engineers convert into custom material models. Third Wave Systems' expertise ensures the user can be confident of the results and analysis completed using Third Wave Systems modeling products.



Residual Stress Analysis for Surface Quality Prediction

## ADVANCED CONSTITUTIVE MATERIAL MODELS

Material behavior under machining conditions is inherently nonlinear. For example, pressure on a cutting edge turning Inconel at 300 SFM or milling at 3000 SFM results from a complex interaction of thermal-softening and strain-hardening as the material is sheared. Cutting test output can be beneficial in certain situations but is severely limited in its predictions over a wide range of cutting conditions. By comparison, Third Wave Systems' advanced material models are based on fundamental material properties, capturing nonlinearity, which provides better predictions and consistent results. This is the best and only comprehensive way to understand machining processes.

## EXPLICIT-DYNAMIC FEM SOLVER

Third Wave Systems' Explicit-Dynamic FEM solver contains the critical algorithms needed for machining modeling. Accurately modeling the machining process requires an understanding of the energy distribution at the workpiece-tool-chip interface that can be effectively analyzed only through a thermo-mechanically coupled system. The separation of the chip and its flow over the rake face requires solving the multi-body contact problem. Advanced adaptive meshing algorithms are needed to intelligently manage the extreme deformation in the cutting zone. In addition, the usage of High-Performance Computing (HPC) technology is critical to managing the various complexities in machining while providing reliable results as quickly as possible.

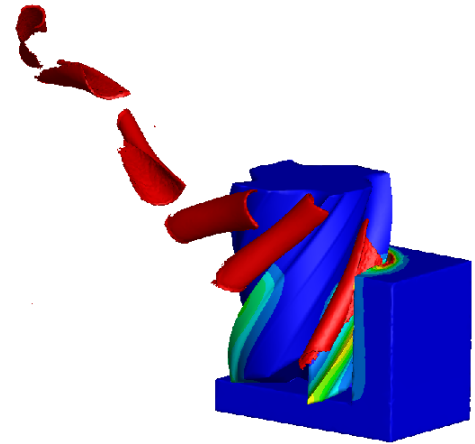
## MACHINING TECHNOLOGY | MODELING SOLUTIONS

### AdvantEdge: Finite Element Analysis

AdvantEdge, is the premier CAE product for modeling material removal processes. The experimentally validated material modeling technology, coupled with advanced Explicit-Dynamic Finite Element Analysis (FEA), gives engineers access to more information than trial-and-error testing. This enables them to make better decisions. AdvantEdge is used to understand the “whys” of tool performance by providing a virtual testing environment for evaluating tool designs, machining process parameters and new materials.

The users can:

- Speed-up time to market through reduction in design iterations
- Improve tool performance
- Boldly innovate by leveraging High Performance Machining techniques
- Use AdvantEdge easily as it is designed for Non-FEA experts



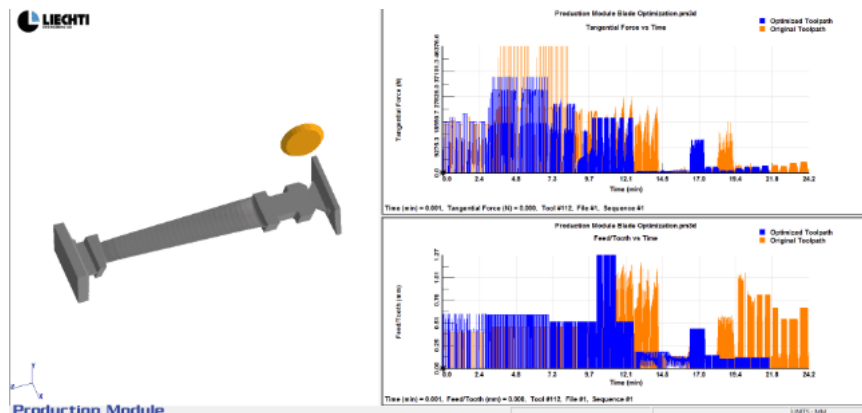
### Production Module: NC Optimization

Production Module is the premier CAE product for modeling machining at the toolpath level. Production Module integrates advanced, experimentally validated, FEA driven material models, with CAD/CAM into an easy to use system for analyzing and improving machining processes. This gives engineers more information than trial-and-error testing, enabling Bold Innovation. TWS leading engineers with in-depth knowledge provide the users in-house support across numerous industries.

Production Module was born of the idea that powerful software can solve the most complex problems. It is used to:

- Dramatically reducing machining time
- Provide best-in-class machining analysis
- Reduce unscheduled downtime
- Accelerate decision making with advanced algorithms

Third Wave Systems has developed XChange interface packages for CATIA, Mastercam and Siemens NX. These interfaces were developed to streamline Production Module project setups so users can quickly and efficiently optimize milling and turning toolpaths to achieve significant cycle time savings.



Liechti Engineering AG used Production Module to optimize radial force by load-per-unit length for roughing operations. Results were 23% cycle time savings and improved tool life with uniform roughing envelope.



# ThirdWave

**Bold innovation in motion™**

## CASE STUDY - Complex 5-Axis Machining

### Background

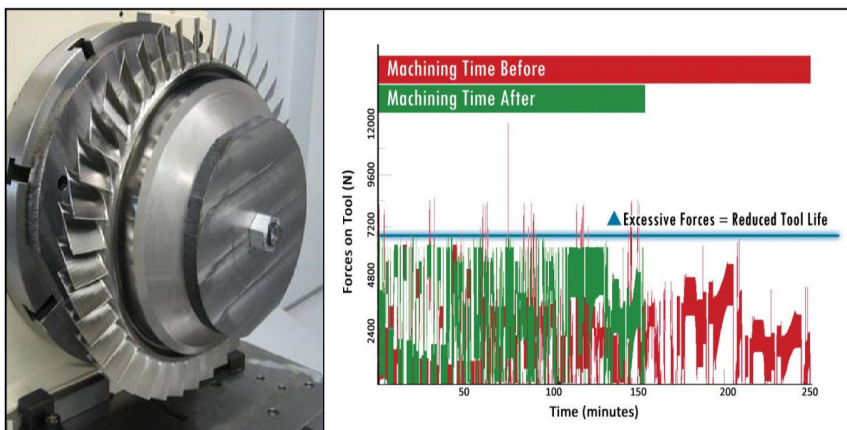
Third Wave Systems products, AdvantEdge and Production Module, model machining of metal with a physics-based approach that gives users the opportunity to lower cycle time and recurring costs while improving part quality. Third Wave Systems developed and demonstrate 25-50 percent cycle time reductions on jet engine components and cases, made of titanium and nickel alloys.

### Engineering Approach

Third Wave Systems used its existing software as the technology platform. The software was expanded to model nickel and titanium alloys relevant for jet engine manufacturing. TWS modeled detailed-level toolworkpiece machining and completed machine testing to validate the model outputs. The model allowed toolpathlevel analysis and provided engineers the ability to model CNC machining operations on full part programs. Engineers are able to predict and optimize high forces and temperatures during machining and control them through feed and speed selection.

### Results

The affordability AdvantEdge and Production Module deliver was demonstrated successfully by several aerospace engine suppliers. Third Wave Systems software products have impacted profitability by delivering 20 percent improvements in machining time for turned parts and 35 percent for milling, all while increasing tool life.



Jet Engine Component

To learn more about Third Wave Systems products and services, visit [www.thirdwavesys.com](http://www.thirdwavesys.com). If you'd like to setup a live web demonstration for AdvantEdge or Production Module, contact us at [sales@thirdwavesys.com](mailto:sales@thirdwavesys.com), or +1-952-832-5515.