

Transition

An example of Air Force supported SBIR/STTR technology that has been transitioned into an Air Force or other DoD system or subsystem or used by Air Force test ranges and facilities or maintenance depots.

SBIR Topic Number:

AF01-134

SBIR Title:

Improved Titanium Machining Process

Contract Number:

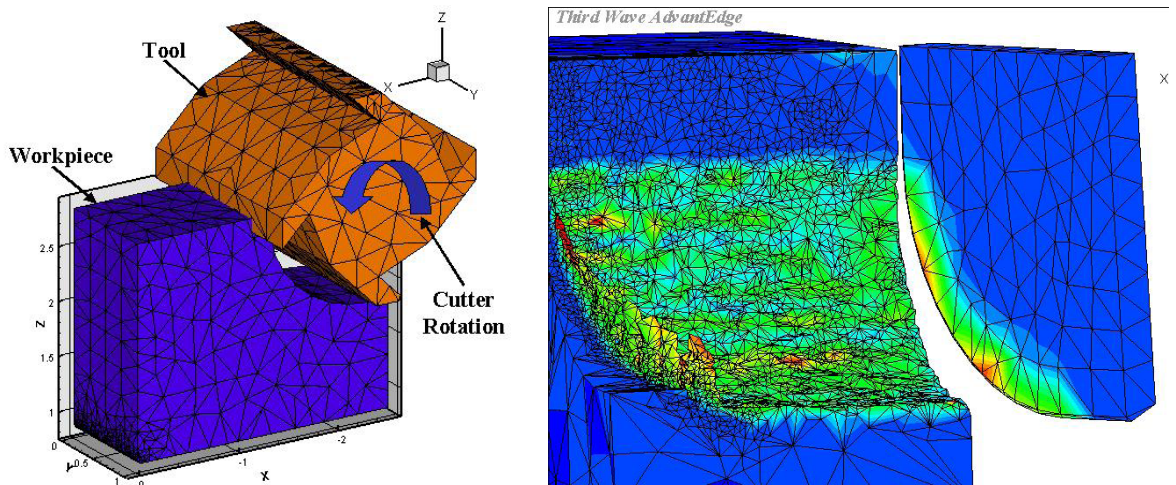
F33615-02-C-5320

SBIR Company Name:

Third Wave Systems, Inc.
Minneapolis, MN

Technical Project Office:

AFRL Materials & Manufacturing Directorate, Wright-Patterson AFB, OH



Left: Depiction of multiple tooth cutting with variable chip load. Cutter rotates and feeds forward relative to the workpiece, providing enhanced capability for HSM modeling of titanium. **Right:** Tracking heat transfer into the workpiece and chip. Tool is progressing into second pass and utilizing heat generated from the first pass.

Improved Titanium Machining Process

- The Air Force needs improved high speed machining (HSM) techniques that can significantly increase metal removal rates and promote cost efficiencies
- Third Wave Systems (TWS) enhanced a non-commercial version of its Computer Aided Engineering (CAE) software, AdvantEdge FEM, to simulate various cutter geometries and process conditions, ultimately identifying high-opportunity operating envelopes for titanium machining
- AdvantEdge FEM allows users to increase material removal rates, improve tool life, predict chip shape, shorten product design cycles, reduce trial and error testing, and improve part quality through residual stress prediction
- TWS's customers include Department of Defense prime contractors such as airframe builders and jet engine manufacturers as well as automotive companies, major cutting tool suppliers, and metals suppliers

Air Force Requirement

Recent advances in the high speed machining of aluminum based materials have significantly reduced the cost of aluminum aerospace structures. In order to improve machining productivity and reduce finished product cost, new and innovative concepts are being sought which have the potential to significantly improve metal removal rates and machining efficiencies. In particular, specific opportunities are being sought in development of improved cutting tool and machining technologies that could significantly increase metal removal rates.

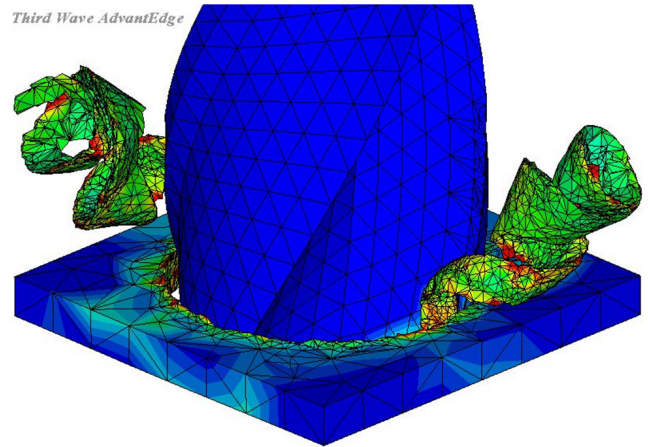
SBIR Technology

High speed machining (HSM) techniques save industry millions of dollars each year. In addition, research utilizing physics-based modeling into the thermal and mechanical roles of the cutting tool and workpiece has led to the ability to thermally tune the machining process, resulting in lower cutting forces and higher material removal rates while maintaining tool life.

Third Wave Systems (TWS) enhanced a non-commercial version of its Computer Aided Engineering (CAE) software, AdvantEdge FEM, to simulate various cutter geometries and process conditions, ultimately identifying high-opportunity operating envelopes for titanium machining. A variety of component technologies were advanced from AdvantEdge FEM's two-dimensional setting to a new three-dimensional environment, building upon successive modeling component technologies to provide deeper insight into the machining process. Using AdvantEdge FEM, TWS demonstrated the feasibility of doubling of metal removal rates while maintaining tool life through the correct combination of tooling geometry and process parameter selection.

Transition Impact

Today, the commercially-available AdvantEdge FEM 3D software is the first modeling package dedicated to the three-dimensional modeling of material behavior during cutting conditions and the cutting process. AdvantEdge FEM allows users to increase material removal rates, improve tool life, predict chip shape, shorten product design cycles, reduce trial and error testing, and improve part quality through residual stress prediction. Additionally, the modeling technology provides a baseline platform for derivative software products that can be used by commercial airframe designers for distortion prediction, and CNC programmers for tool path optimization.



Drilling analysis of a two-flute twist drill. Temperature profiles are shown with drill completely broken through workpiece with substantial chip formation.

AdvantEdge FEM commercial users are located across the United States, primarily representing the aerospace, automotive, academic, and cutting tool industries. TWS's current customers include Department of Defense prime contractors such as airframe builders and jet engine manufacturers as well as automotive companies, major cutting tool suppliers, and metals suppliers.

Company Impact

This SBIR project provided TWS with valuable opportunities for enhancing the AdvantEdge FEM software and securing its spot as the world's leading CAE machining modeling software. Since the completion of the SBIR project in 2005, the company has experienced consistent growth in software sales, engineering services and staffing, and remains one of the top SBIR award recipients in Minnesota.

In 2008, TWS was awarded an Air Force contract for close to \$3 million to ensure the successful transition of modeling and high performance machining technologies into commercial applications for the efficient and affordable fabrication of titanium integrally bladed rotors used in F135 and F136 engines.



U.S. AIR FORCE

SBIR/STTR

Air Force SBIR Program
AFRL/XP
1864 4th Street
Wright-Patterson AFB OH 45433

AF SBIR/STTR Program Manager: Augustine Vu
AF CPP Program Manager: Richard Flake
Website: www.sbirsttrmall.com
Comm: (800) 222-0336
Fax: (937) 255-2219
e-mail: afrl.xppn.dl.sbir.hq@wpafb.af.mil

