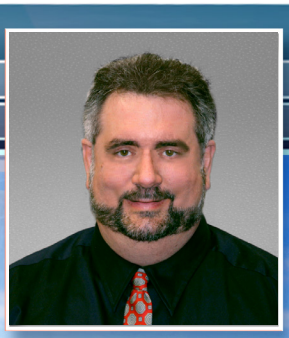
SBIR Success Story

Of the Quarter

2010



Carl Lombard, AFRL/RXMP ▲

IMPROVED TITANIUM MACHINING PROCESS

THIRD WAVE SYSTEMS (TWS)

AFRL/RXMP | Wright-Patterson AFB, OH

▲ *One F-35 component to benefit from the modeling efforts is the forward engine mount, which is currently machined by Nex-Tech Aerospace.*

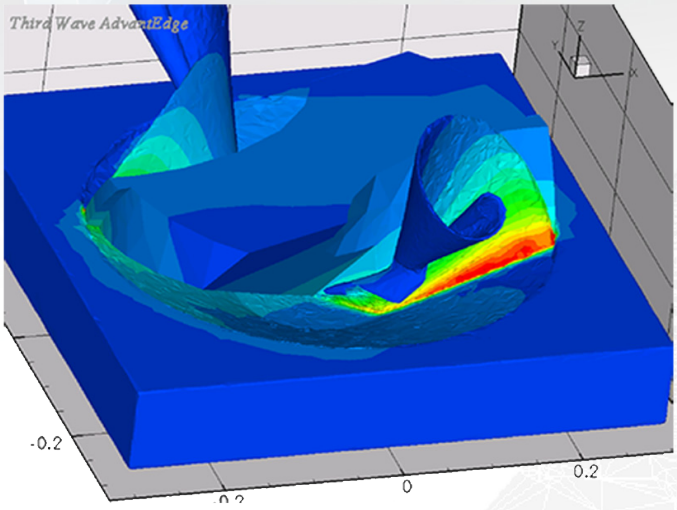
▶ *Bell Helicopter and Third Wave Systems teamed together to improve machining processes for helicopter drive system components on the V-22.*

Air Force Requirement:

Recent advances in the high speed machining of aluminum based materials have significantly reduced the cost of aluminum aerospace structures. However, titanium-based materials have inherently different machining characteristics that make high metal removal rates more difficult to achieve, thus making machining costs a major cost driver in the production of aerospace titanium components. 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. Additionally, research has found that the tooth path frequency in relation to generated heat plays a key role in resulting cutting forces. Knowing this, Third Wave Systems used its CAE software, AdvantEdge FEM 2D and 3D, to simulate a combination of HSM techniques and high frequency tooth-pass (HFTP) machining methods, ultimately identifying optimum machining conditions for titanium.



▲ *Carbide drilling analysis simulated to understand cutting edge temperatures and stresses, an indication of tool wear. Tool geometry was generated using parametric inputs. Variations in the process parameters (feed, speed, etc.) allow customers to determine optimal cutting conditions utilizing standard AdvantEdge FEM outputs (stress, temperature).*

IMPROVED TITANIUM MACHINING PROCESS

THIRD WAVE SYSTEMS (TWS)

SBIR Success Story

SBIR Technology (cont.)

Third Wave Systems' work plan consisted of disciplined, low-risk development of essential analysis tools for HSM/HFTP implementation. AdvantEdge FEM 3D was used to bypass expensive trial and error testing while gaining additional insights not available from test data. Using AdvantEdge FEM, Third Wave Systems demonstrated the feasibility of doubling of metal removal rates (MRR) while maintaining tool life through the correct combination of HSM and HFTP methods.

Transition Impact:

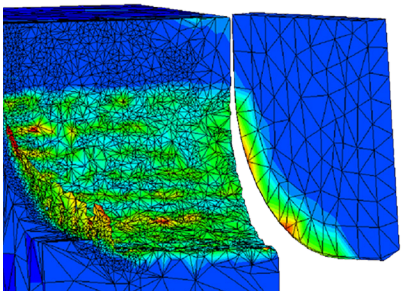
Much of the HSM process is fundamentally an issue of thermal management. Since it was not practical or economical to measure heat and temperatures during cutting operations, and given the costs and time involved for testing, process modeling was truly the tool of choice. Today, the commercially-available AdvantEdge FEM 3D software is the first modeling package dedicated to the three-dimensional modeling of materials in cutting conditions and the cutting process. AdvantEdge FEM allows users such as Boeing and General Electric 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.

Technical Project Office:
AFRL Materials & Manufacturing Directorate
Wright-Patterson AFB, OH

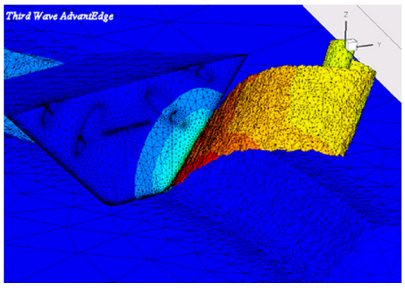
SBIR Company:
Third Wave Systems, Inc. | Minneapolis, MN

AFRL/RX SBIR Program Manager:
Ms. Debbie Shaw

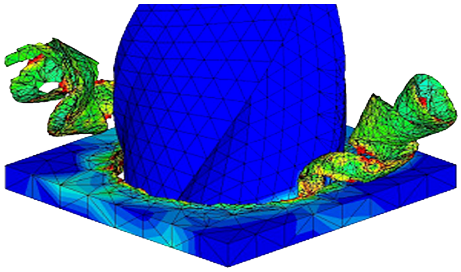
AFRL/RXMP Program Manager:
Carl Lombard



▲ *Tracking heat transfer into the workpiece and chip. Tool is progressing into second pass and utilizing heat generated from the first pass.*



▲ *Indexable milling analysis of chip formation and forces in Ti-6-4. Simulation utilizes the software's STEP file import capability with a Kennametal, Inc. CAD geometry. Importing CAD geometries allows customers to analyze the effect of cutting edge and surface geometries without costly experimental testing.*



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

For more information, contact the Materials and Manufacturing Directorate's Technical Information and Support Center at techinfo@afrl.af.mil or (937) 255-6469.

Approved for Public Release (WPAFB-???????)

AIR FORCE RESEARCH LABORATORY