Improved Titanium Machining Process

PROBLEM/OBJECTIVE

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 different machining characteristics that make high metal removal rates more difficult to achieve.

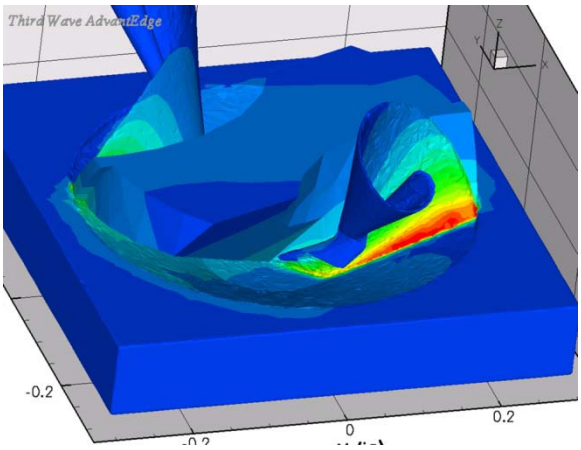
This challenge is a major cost driver for machining costs for the production of aerospace titanium components. In order to improve machining productivity and reduce finished product cost, new and innovative concepts to improve metal removal rates and machining efficiencies were sought. In particular, specific opportunities to improve cutting tool and machining technologies were explored to achieve the desired metal removal rates.

ACCOMPLISHMENTS/PAYOFF

Process Improvement: The Air Force Manufacturing Technology Division awarded a Phase III Small Business Innovative Research (SBIR) program contract in 2008 to Third Wave Systems, Inc. (TWS). The goal was to ensure the successful transition of modeling and high speed machining (HSM) technologies into military applications for the efficient and affordable fabrication of titanium used in F135 and F136 engine components.

Research revealed the relationship between the tooth path frequency, heat generation and the resulting cutting forces. Knowing this, TWS used its computer-aided engineering 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. Using AdvantEdge FEM, Third Wave Systems demonstrated the feasibility of doubling the metal removal rates while maintaining tool life through the correct combination of HSM and HFTP methods.

Implementation and Technology Transfer: AdvantEdge FEM 3D software is commercially available to users in the aerospace, automotive, academic, and cutting tool industry. This software is the first modeling package dedicated to the three-dimensional modeling of materials in cutting conditions and the cutting process.



Simulation of the Drilling Process – Stress State Shown with Red being Highest Stress (Drill Removed)

Expected Benefits and Warfighter Impact: The new modeling software allows users such as Pratt & Whitney 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. HSM techniques will save the aerospace industry millions of dollars each year.

TIMELINE/MILESTONE

Start Date	September 2008
End Date	December 2011

FUNDING

SBIR	$2,970K

PARTICIPANTS

AFRL ManTech, WPAFB OH
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