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US Air Force Announces Sustainable Manufacturing Successes

"Sustainable Manufacturing is the creation of manufactured products that use processes that minimize negative environmental impacts, conserve energy and natural resources, and are economically sound and safe for employees, communities, and consumers." (Adapted from the United States Department of Commerce definition)

The Air Force (AF) Manufacturing Technology (MT) Program is fulfilling Department of Defense, AF, and industry strategic intent for sustainability by maturing sustainable manufacturing practices. This enhances the production capability necessary to fabricate weapon systems with reduced resource consumption utilizing environmentally sustainable processes while preserving performance requirements. AF MT is studying methods to accelerate adoption of a sustainable manufacturing philosophy within the defense aerospace industry to ensure that it is on the leading edge of addressing the social, resource conservation, and environmental stewardship challenges. As first steps, AF MT will:

- identify, analyze, and document methods, tools, and equipment used in industry to perform sustainability assessments for the defense aerospace industry,
- mature and adapt quantitative and qualitative tools that will enable the aerospace industry to identify sustainable manufacturing opportunities throughout the enterprise when making manufacturing decisions,
- develop a consensus within industry of sustainability metrics that can be applied across the aerospace enterprise, and
- integrate assessment tools into standard operating procedures for validation of manufacturing improvement results.

AF MT is initially focusing on sustainable manufacturing for machining metallic component parts for aerospace structures and engines.

As part of an initial machining tool project, the AF worked with the National Center for Defense Manufacturing and Machining (NCDMM) and GKN Aerospace of St. Louis, MO, and conducted a sustainable machining cell project assessment in December 2010 that focused on minimizing and optimizing the inputs and outputs required to transform material into defense aerospace products that support fighters, transports, and helicopters. The assessment delivered a roadmap for technology solutions to reduce operational energy consumption and waste products at various tiers within the manufacturing enterprise of GKN. Specifically, the project:

- used assessment tools in the GKN machining cell to conduct an energy consumption, expendables, and waste analysis to determine opportunities for inserting advanced sustainable technologies,
- conducted business case assessments to justify candidate projects for transitioning advanced efficient technologies, and
- implemented the first of several identified advanced technologies at GKN and quantified the benefits.

From December 2010 through March 2011, sustainable technologies were implemented with consideration to return on investment and available resources. Early successes include:

- an 11 percent reduction in water and coolant consumption through the implementation of a cutting fluid recycling process at the GKN Aerospace St. Louis facility,
- a 300 percent increase in tool life for titanium facing operations using Kennametal Beyond Blast Technology (BBT), and
- a 205 percent increase in metal removal rates, overall reduced cycle time, reduced energy consumption, and increased tool life through the implementation of Volumill tool path optimization software.

Details of the Sustainable Technologies Implemented

Coolant Recycling Process

Historically, GKN Aerospace St. Louis used a semi-synthetic coolant with limited success. The coolant required regular adjustments to maintain proper acidity and continuous monitoring for bacterial growth. In addition, the semi-synthetic coolant emulsified machine oils and was not designed to be a recyclable product. Finally, contaminants such as tramp oil, machining fines, and dirt reduce the effectiveness of the cutting fluid and eventually require the fluid to be replaced. The assessment indicated that this was an area that could be made more sustainable. Thus, as a part of this effort, GKN evaluated six alternative cutting fluids for machining aluminum and titanium alloys. The evaluation considered cost per gallon, ability to remove residue from machined components, cutting fluid maintenance requirements, disposal costs, cutting tool performance, sump stability, machine tool maintenance, fluid management, and the ability to recycle the product. Based on the test data collected, GKN selected TRIM MicroSol 585XT working fluid from Master Chemical Corporation (MCC). The new fluid also allowed GKN to implement a centrifuge recycling system also supplied by MCC.

The transition to a new cutting fluid has been seamless with no negative impact on the machining operations. The recycling process has been in place for three months and GKN has realized the following savings:

- reduced coolant usage 7.5 percent per pound of aluminum/titanium generated chips,
- reduced both raw coolant and water consumption by 11.2 percent when compared to 2009 values,
- reduced waste fluid disposal requirements,
- eliminated anti-bacterial, anti-stain, acidity balancers, and defoamer additives,
- recycled 13,775 gallons of metal cutting fluid in December 2010 and January 2011, and
- improved working conditions by using a more employee-friendly cutting fluid.

GKN St. Louis is projecting a $6,000 monthly savings through the implementation of the cutting fluid recycling process.

Beyond Blast Technology

The assessment process indicated that increasing tool productivity and life would result in substantial savings in energy and tooling costs. Previously, GKN utilized a Kennametal RPF cutter for the majority of the titanium facing operations on the machining cell investigated in this project. In the past year, Kennametal released BBT, a new cutting tool technology that creates

the potential for increased productivity and improved tool life. BBT utilizes a patented through-the-insert cooling technology to direct cutting fluids through the insert and more effectively deliver fluids to the interface between the insert and chip.

A baseline using the RPF cutter and GKN accepted machining parameters was established and life testing for the insert was conducted at the NCDMM Advanced Manufacturing Laboratory in Latrobe, PA. The NCDMM conducted a life test of the BBT cutter using identical cutting parameters and found the BBT tooling increased tool life by more than 33 percent per cutting edge. In addition, the BBT cutting insert is a round insert with six effective cutting edges compared to the two effective cutting edges of an oval RPF insert. This provides three times the number of edges and three times the tool life. The total improvement with the extended tool life per edge and the increase in the number of effective edges resulted in more than a 300 percent increase in tool life.

Volumill Software Implementation

The NCDMM and GKN investigated a variety of software packages to maximize machine efficiencies and improve titanium alloy removal rate. As part of the investigation, the team obtained a one month free trial of Volumill Universal software to evaluate the software capabilities and conduct machining trials using the Sustainable Machining Cell. Volumill is an ultra-high performance tool path optimization technology that improves the tool path using high-speed continuous tangential motion rather than sharp, interrupted movements. Benefits also include maximizing the time a cutting tool is engaged with a work piece, stabilizing the cutting conditions, increased metal removal rates, decreased power spikes, reduced energy consumption, and increased tool life.

Early testing showed a 205 percent increase in metal removal rates for the pocketing operations on a GKN standard test component. A review of the machine tool load indicated a reduction in per unit power consumption as well as overall power consumption during the machining operation. Finally, the advanced tool path allowed additional features to be machined with fewer tools. A more complete analysis is required to fully quantify the benefits of this software and additional trials are planned for the next phase of the project. By combining this with other advanced technologies such as extreme high flute cutting tools, the team is confident they will be able to safely double machine output, extend tool life, reduce energy consumption and machine downtime, while creating a much more productive and competitive manufacturing enterprise in the global marketplace.

Points of Contact

For additional information on this technology contact the Technical Information and Support Center, Manufacturing Technology Division, Materials and Manufacturing Directorate, Air Force Research Laboratory at TechInfo@afrl.af.mil or 937-255-6469. To receive more information about AFRL/RX visit the Homepage at www.wpafb.af.mil/arfl/rx/.

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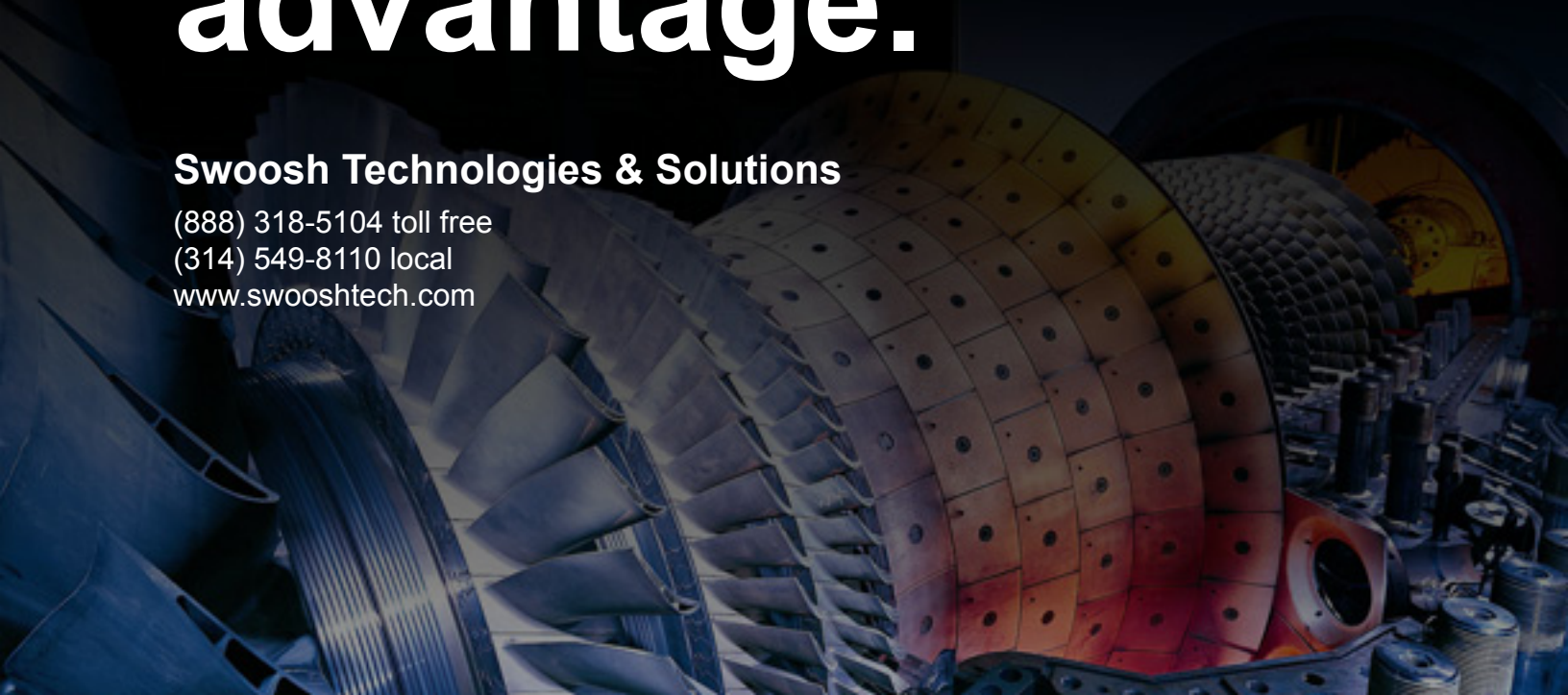

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