

## Report Documentation Page

*Form Approved*  
*OMB No. 0704-0188*

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE <b>10 FEB 2004</b>			2. REPORT TYPE <b>Technical, Success Story</b>			3. DATES COVERED <b>14-09-2003 to 10-02-2004</b>		
4. TITLE AND SUBTITLE <b>ISO Grid 155 mm Howitzer</b>			5a. CONTRACT NUMBER			5b. GRANT NUMBER		
6. AUTHOR(S)			5d. PROJECT NUMBER <b>03-0008-09</b>					
			5e. TASK NUMBER					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>National Center for Defense Manufacturing &amp; Machining,1600 Technology Way,Latrobe,PA,15650</b>			8. PERFORMING ORGANIZATION REPORT NUMBER			10. SPONSOR/MONITOR'S ACRONYM(S)		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			11. SPONSOR/MONITOR'S REPORT NUMBER(S)					
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>								
13. SUPPLEMENTARY NOTES								
14. ABSTRACT <b>The US Army's Armament Research, Development, and Engineering Center (ARDEC) at Picatinny Arsenal in Rockaway Township, N.J., was commissioned to reduce the weight of the 155mm howitzer. Their efforts included replacing an approximately 4' x 10' x 1" steel ISO grid support panel with one made of titanium 6AL-4V. Titanium weighs 45 percent less than steel, is stronger and more resilient, and doesn't rust. However, its unique properties also make it difficult to machine productively. ARDEC was spending excessive time milling a pattern of 2.25"-wide triangular pockets into the grid to further reduce its weight. ARDEC presented this problem to the National Center for Defense Manufacturing &amp; Machining (NCDMM) and requested their assistance.</b>								
15. SUBJECT TERMS <b>Success Stories; National Center for Defense Manufacturing &amp; Machining; NCDMM; ARDEC; US Army's Armament Research, Development, and Engineering Center;</b>								
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT		18. NUMBER OF PAGES		19a. NAME OF RESPONSIBLE PERSON	
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>	<b>1</b>		<b>1</b>			

## PROBLEM / OBJECTIVE

The US Army's Armament Research, Development, and Engineering Center (ARDEC) at Picatinny Arsenal in Rockaway Township, N.J., was commissioned to reduce the weight of the 155mm howitzer. Their efforts included replacing an approximately 4' x 10' x 1" steel ISO grid support panel with one made of titanium 6AL-4V. Titanium weighs 45 percent less than steel, is stronger and more resilient, and doesn't rust. However, its unique properties also make it difficult to machine productively. ARDEC was spending excessive time milling a pattern of 2.25"-wide triangular pockets into the grid to further reduce its weight. ARDEC presented this problem to the National Center for Defense Manufacturing & Machining (NCDMM) and requested their assistance.



The "proof-of-concept" mockup part used to test new tooling and manufacturing processes

## ACCOMPLISHMENTS / PAYOFF

### Process Improvement

High chip loads are required to mill titanium productively. In light cuts, the alloy's resilience will cause a cutting tool to rub instead of cut, generating heat, high pressures, and short tool life. But heavy cuts require high torque and can also generate heat, so a balance of parameters is required. NCDMM's alliance partner, Kennametal Inc., recommended a combination of advanced tooling and manufacturing techniques to boost productivity. Solid-carbide center-cutting endmills were tested using trichoidal programming techniques. These machining methods employ radial movement of the cutter to maintain constant feed rates and keep the endmill continuously in the cut, maximizing milling efficiency.

### Implementation and Technology Transfer

ARDEC will be implementing NCDMM's recommendations on a horizontal machining center using 200 pounds per square inch (psi) flood coolant, which facilitated removal of chips. The end mills ran at cutting speeds 100 percent higher than the 80-100 surface feet per minute (sfm) speeds used previously. Feed rate was increased proportionately to balance chip load. Machining time for the grid dropped from 400 hours to 120 hours, a reduction of 70 percent. Surface finish improved from 80 root mean squared (rms) to below 32 rms. ARDEC engineering technician, Bill Bakula, said, "We did a 6" x 12" sample part, and the NCDMM tried different speeds and feeds and different tooling. The results," he said, "were great. This brings us up to date with new techniques."

### Expected Benefits

In summary, implementation produced:

- 70 percent milling time reduction
- Surface finish improved by over 200%
- A lighter, stronger, corrosion-resistant component produced more efficiently

At a nominal machine time rate of \$60 per hour, savings in machining time alone amount to \$14,000 per grid. Over the entire intended production run of 600 lightweight howitzers, machine time savings would total \$8.4 million. Less quantifiable but nevertheless real further savings include reduced expenditure of energy in transporting the howitzers. Most importantly, the lighter weapons will enhance the responsiveness of the units that use them.

## TIME LINE / MILESTONE

Start Date ..... Sept 03  
End Date ..... Feb 04

## PROJECT FUNDING

NCDMM funding ..... \$10K

## PARTICIPANTS

ARDEC/ Picatinny Arsenal  
NCDMM  
Kennametal Inc.