HIGH PRECISION METAL FORMING

Mr. Jerry Dickson, US Army AMCOM
Mr. Bill Baschnagel, Creare, Inc.
Mr. Albert Tatka, US Army TACOM-ARDEC
Why?

• Sabot is a critical component to launch a smaller diameter subprojectile
• M919 sabot is parasitic – not carried to target i.e. not a direct lethality contributor
• Sabot was 20% of M919 cost
Background

• Although parasitic, sabot critical to launch subprojectile successfully
• Modeling indicated stress loads on 1st and last three buttress teeth to approach 127ksi
• The M919 uses a 7075 AL alloy (w/ T6 temper) that is CNC machined by the contractor
AMCOM MANTECH identified High Precision Metal Forming (HPMF) as capable of molding high strength, high precision AL millimeter wave housings.

- Computer-controlled 100 ton press equipped w/ heated die set
Molded Sabots

- Die set built to mold M919 Sabots
- Fixed volume 7075 Al billet heated to 450°C
- Die closes under timed control
- Reliefs cut for flashing
- Proprietary die lube
Machined vs. Molded Sabots
ARDEC Analysis

Figure 1a. Sabot No. 72 in the “as-received” condition, teeth facing up.

Figure 1b. Sabot No. 72 in the “as-received” condition, outer surface.
ARDEC Analysis

- ARDEC WECAC sectioned formed sabots to observe grain structure and flaws
- Laps found in non-critical
- Difficult to move metal thru cap groove
ARDEC Analysis Cont’d

- Additional flaws identified
- Bulges found in saddle area
- Rough sections found in band seat
ARDEC Analysis Cont’d

- Teeth fully formed, no laps or other flaws noted in teeth area that would result in weakened structure
- Go ahead given to produce ballistic test hardware
Ballistic Test Build

• During forming, die set not closing in parallel
• Inspection noted that aft section slightly oversized
• Thought not to have dramatic effect on finished assembly
• Twenty four sets fabricated
• Aft scoop machined, heat treated and cleaned
• Finished parts provided to GD-OTS to anodize and assemble into M919 cartridges
Machined Sabot Projectile

X-rays at 20” from Muzzle @ +21°C
Molded Sabot Projectile

Shot #4
+21°C
Molded Sabot Projectile

Shot #5
+21°C
Machined Sabot Projectile

At muzzle

20” from muzzle

Shot #9
-32°C
Machined Sabot Projectile

At muzzle

20” from muzzle

Shot #10

-32°C
Machined Sabot Projectile

At muzzle

20” from muzzle

Shot #11
-32°C
Conclusions

• Oversized aft DIA resulted in excessive spin
• Excessive spin may have contributed to structural failures noted
• Buttress teeth survived launch
• Additional effort required to optimize
• Process could have direct benefit to other DoD programs