The Development of Roto Peening

A brief history on shot peening

Shot peening is a metal surface treatment that can extend the fatigue life of most metals. Its ancestor is "hammering". Evidence of hammering a metal to shape and harden its surface can be traced back as far back as 2700 B.C. to a gold helmet found at Ur (Mesopotamia). The discovery of shot peening's ability to induce compressive stresses to combat fatigue most likely began in the automotive industry in the late 1920s. It is difficult to attribute the discovery to one person or even to one automotive firm as it seems to be one of those inventions whose time had come to fill a crucial need. The discovery is referred to as an "accident" in many sources—sand blasted valve springs did better under test than springs that hadn't been sand blasted. References to shot peening can be found in research papers and records of automotive manufacturers such as Buick, Chevrolet, and Cadillac. (For a more in-depth look at the history of shot peening in the automotive industry, download "How, When and by Whom was Mechanical Prestressing Discovered" at www.shotpeener.com/learning/learning.htm.)

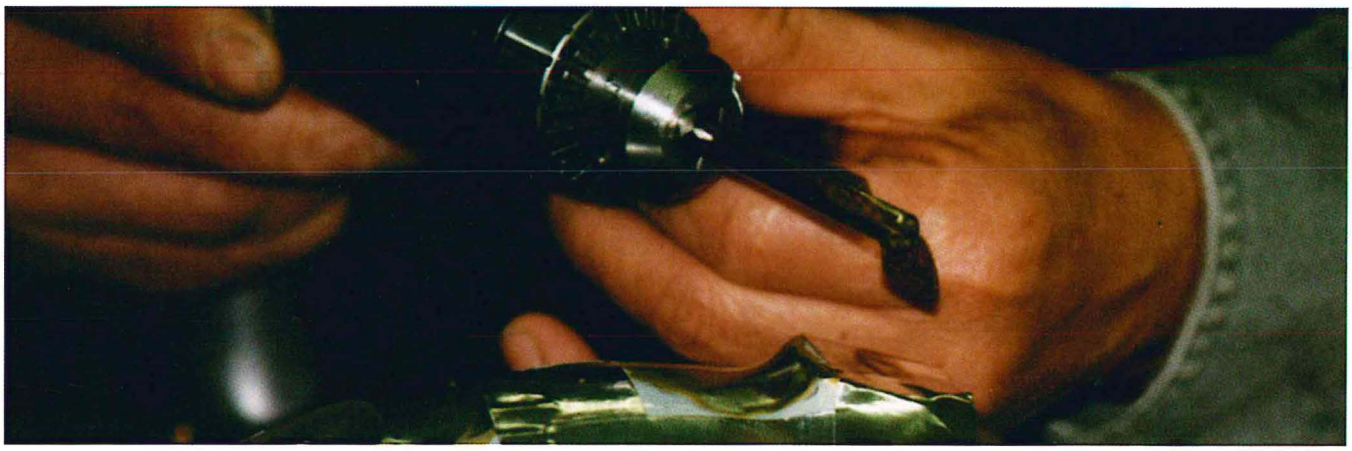
Initially, shot peening was not used extensively outside of the automotive industry except by WW I munitions manufacturers who shot peened rifles to prevent fatigue failures. In fact, the military should be credited for the further development of the process when it began to shot peen the high-performance metals used in WW II.[1]

Shot peening takes off during the Vietnam war

Shot peening gained major acceptance in the Vietnam war because of its contribution to aviation. During the Vietnam war era, US Army helicopters, plus a small number of fixed-wing aircraft, were used in greater numbers than had ever been seen before in a land war. US Army aviation had to expand so dramatically that it became, on its own account, the world's third-largest air force.[2]

The increased use of aircraft led to the development by 3M™, an international technology company, of a type of shot peening called roto peening. According to Peter Fritz, ISO Product Manager/Team Leader at 3M, "In the 1960s, titanium became popular with aircraft manufacturers because of its great structural strength and light weight. But early on, it was not understood that the scrapes and gouges routinely occurring during maintenance could lead to fatigue. There could be some failures of titanium helicopter rotors, for instance, that peening could prevent."

3M had the solution—the company worked with tool manufacturers to adapt an existing flexible shaft tool into a shot peening tool using



The 3M™ roto peen flap assembly TC330. Photo was taken during an Electronics Inc. roto peening training session at a military base. For more information on roto peening training, call EI at 1-800-832-5653 or (574)256-5001.

the 3M roto peen flap assembly TC330. Shot peening using TC330 consists of a slotted shaft mounted to a tool to which is attached flexible flaps on which shot particles are bonded. As the unit is rotated against the metal workpiece, the shot on the peening head impacts and peens the metal workpiece. The TC330 has a small footprint, is portable, and replaces free-flying shot. Because it is capable of repairing gouges, scrapes and corrosion in small and hard-to-reach areas, it was ideal for shot peening helicopter rotors.

The rotor housing that connected the shaft to the rotors was the most critical service part on the helicopter. Any nicks, dings, or scratches on that critical part had to be removed and stress-relieved because they could become the concentration site for stress. These sites are called "stress risers" as huge stresses get concentrated at the defect site. Rotors are also shot peened for the same reason. Any visual defect in the surface appearance of a rotor will get a helicopter taken out of service until the defect is remedied.

—Peter Fritz, 3M

Shot peening and a Vietnam Helicopter Pilot

The helicopter on our front cover is an attack helicopter—the AH-1G Huey Cobra. The photo was taken by Mike Austin while he was enroute to a recon (Hue area, 1972).[3] Mike (Blue Ghost 23) was a Vietnam helicopter pilot and a recipient of Distinguished Flying Cross. Here's what the helicopter rotor meant to this chopper pilot:

The rotor hub was every bit as critical as the mast because it held the 48' diameter blades as they spun at 324 rpm, which exerted tremendous centrifugal force on it, as well as the incredible dynamic stresses they induced in flight, especially when the "tip speed" of the advancing blade (the one rotating into the direction of flight) approached the speed of sound when a Cobra gunship dove toward a target. Like most combat pilots, I was sometimes too busy to watch the airspeed in a dive, so relied on the distinctive shudder that shook the aircraft to warn me when it was approaching its redlined airspeed before pulling out of the dive at 3 G's. The rotor hub was then subjected to about 21,000 pounds of vertical lift in addition to the centrifugal forces I mentioned earlier. And it concentrated all that force to a 4 inch diameter mast, what a marvel that it all held together!

—Mike Austin

The future of roto peening

The TC330 was qualified at Wright-Patterson Air Force Base in Dayton, Ohio and written into the military specifications MIL-R-81840 and MIL-R-81841 in the early 1970s. Today, civilian and military aircraft mechanics are trained on the use of the 3M roto peen flap assembly TC330. As the demand increases for safer, lighter and stronger metals, the use of roto peening and shot peening will continue to grow in the automotive and aerospace industries.

Warrant Officer Mike Austin, flying in the back seat of a Cobra

Please express my utmost gratitude to your industry for its contribution in helping make our helicopters as strong and reliable as possible. Helping make a better product also saved lives.

—Mike Austin

[1] 3M™ StemWinder, 10/09/01 [2] http: www.tri.army.mil

[3] AH-1G Cobra enroute to a recon near Hue, 1972. Copyright Mike Austin.