Power Transfer Systems Manufacturing
Chemical Isotropic Super Finishing Processes

PROBLEM / OBJECTIVE

Army helicopters increase in weight during their lifecycle (approximately 50 lbs. per year) as mission equipment packages are upgraded to meet new combat requirements. This increase in weight leads to a degradation in performance and mission capability. Increasing engine horsepower is a solution, but this can increase the stress on helicopter transmissions and the cost to design and qualify a new transmission to accept the higher horsepower.

This project invested in adapting the Isotropic Super Finish (ISF) process to reduce friction, scuffing and noise. ISF is produced in conjunction with high-density, nonabrasive ceramic media, and conversion coating chemicals. When introduced into the machine, this chemistry produces a stable, soft conversion coating on the surface of the metal parts. The rubbing motion across the parts developed by the machine and media effectively wipes the conversion coating off the peaks of the part's surfaces. The surface finish valleys are left untouched. The conversion coating is continually re-formed and wiped off, resulting in a level surface. ISF also reduces contact and bending fatigue acting on gears in helicopter transmissions.

The objective is to significantly increase reliability of power transfer systems by increasing gear contact, fatigue, life, increasing gear tooth bending fatigue life, decreasing the coefficient of friction, and extending the performance and service life of the gear sets to reduce downtime and maintenance costs.

ACCOMPLISHMENTS / PAYOFF

Process Improvement The ISF process is controllable, repeatable, and robust. Stock removal was easily monitored during the process and initial measurements were used to determine the amount of stock removal required to attain a super finished surface. In addition, it was shown that the selection of proper media mix increased uniformity of metal removal on the gear flanks.

Implementation and Technology Transfer:

The project completed with a 200-hour endurance test of a UH-60 tail rotor and intermediate gearbox with excellent results. The gearboxes with ISF gears ran at lower temperatures with increased torque. Scoring tests were completed in March, 2004. Implementation was started at Sikorsky Aircraft on both military and commercial helicopter gearboxes. Industry-wide implementation is expected as more designers include ISF in their specifications.

Several new ISF projects have been initiated since PTSM completed. These include: Horizontal Hinge Pins on the Chinook, all five gear boxes/transmissions on the Chinook, the Tailrotor Gear Box on the Apache, and the Black Hawk input module. Increased joint service coordination has also begun with the US Navy REPTECH Program and the ISF efforts they have initiated on the H-46 helicopter program.

Expected Benefits:

Applying ISF to SAE 9310 gears has demonstrated a 300% mean life improvement due to an increase in resistance to contact fatigue. This translates into a 12-15% reduction in maintenance hours per flight hour (up to $10 per flight hour). A 10% increase in bending fatigue resistance is expected based on testing of PYROWARE-53 spur gear sets at the Gear Research Institute. NASA Glenn Research Center tests indicated increased contact fatigue resistance.

TIME LINE / MILESTONE

Start Date	November 2001
End Date	September 2004

FUNDING

Army ManTech (AMRDEC)	$0.640M
Aviation Eng Dir (AMRDEC)	$0.050M
Sikorsky Aircraft	$0.025M
REM Chemical Inc.	$0.025M

Participants:
AMRDEC, Alion Science and Technology
Sikorsky Aircraft Corporation, REM Chemicals, Inc.
Naval Air Systems NAVAIR, Pax River