Turbine Technologies, LTD

PT-50 Turboshaft Engine Development Update

Issue 9 - April 6, 2007

Engine Development Recap - August 2005 to Present

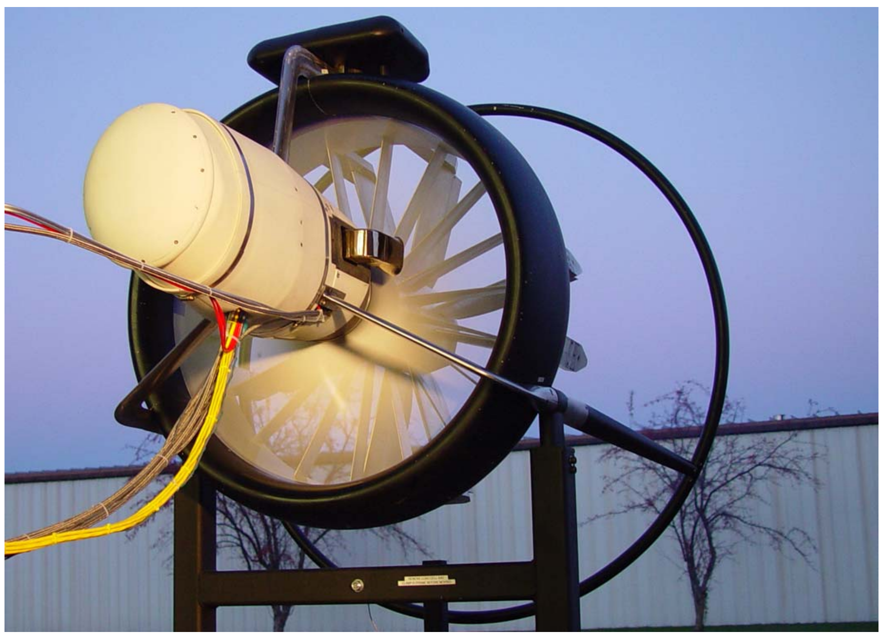
Since 2003, Turbine Technologies, LTD (TTL) has been actively engaged in the development of a family of light turboshaft engines intended for aerospace and industrial applications. A series of Engine Development Updates published during the spring of 2005 detailed activities specific to the model PT-50 Turboshaft Engine designed from the onset as a robust UAV propulsion solution capable of operating reliably on a wide variety of heavy fuels including diesel, kerosene and military standard JP-8.

Success with an early proof-of-concept engine lead to an integration contract in the summer of 2005 that precluded any further public progress reports regarding the PT-50 as well as TTL activities in general. With the conclusion of that contract, we are once again able to share our Engine Development Updates with the general aerospace community.

This particular issue is intended to recap our activities over the past two years and outline our future plans as we prepare the PT-50 for customer acceptance and initial quantity production. Regular updates will be published to further acquaint you with the PT-50 Engine, its operating performance and production engine availability.

UAV Program Propulsion Selection

In August 2005, TTL entered into a subcontractor relationship with a major U.S. defense contractor. This fortune 500 company selected the PT-50 Turboshaft Engine as the propulsion unit for its entry in an industry wide vertical takeoff and landing (VTOL) UAV competition. This UAV program was itself part of a larger initiative to define future war fighting systems. Two other internationally recognized defence companies also participated in the competition.

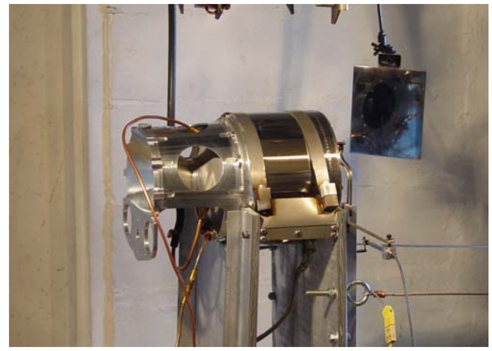


The PT-50 is ideally suited for the UAV application considering the need for very small size, high power density and exceptional starting and operational reliability. A specific requirement of the vehicle was the ability to fly somewhere, land, shutdown and restart remotely. This is an especially difficult requirement to meet with conventional ignition or compression engines, yet becomes a trivial problem with the PT-50 and its integral starter/generator and electronic autostart system. Countless start/stop cycles were demonstrated in a variety of ambient temperature conditions with no false or hung starts. A lightweight, baseball sized lithium-ion battery is the only power source required for these starts.

A full-scale wind tunnel model of the vehicle was used for engine to airframe integration activities as well as in-vehicle testing. All preliminary operational and performance goals were met during the course of the contract. Measured thrust values were more than adequate to fly the vehicle and the engine operated well within temperature and torque limits. Details regarding engine progress throughout this program follows.

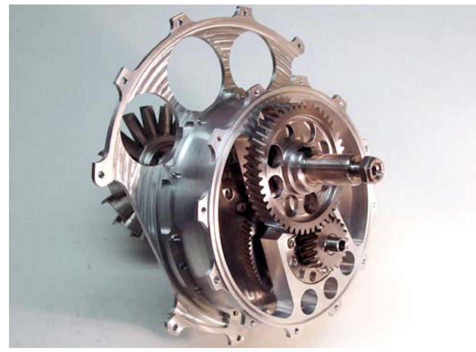
PT-50 Core Engine Run

The complete engine core in its original configuration was first run in the company test cell on August 3, 2005. This test was simply to verify basic engine operation and combustion sustainability. The test was successful with a total run time in excess of five minutes. During this first run, the engine operated at an even and consistent RPM with no tendency to depart from a selected speed. Observed vibration was non-existent. This test provided the assurance that the core components were suitable and that testing with reduction and accessory gearboxes could commence.



Accessory and Reduction Gearbox Completion, First Complete Engine Tests

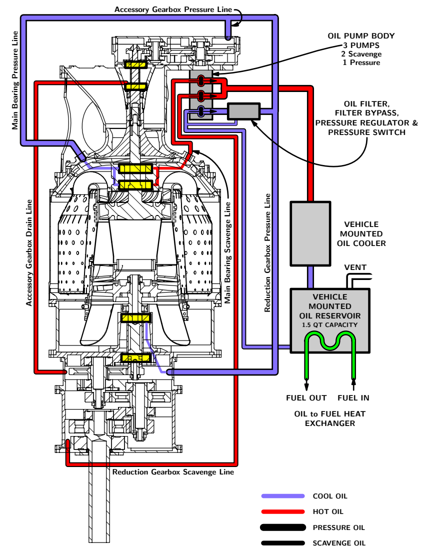
Component parts for the two gearbox assemblies were machined in September, 2005. The accessory gearbox was assembled first and tested on the core engine throughout the complete operating range of the engine. The reduction gearbox along with the necessary power turbine duct and containment systems were finished and mated to the engine in mid October. Testing of the engine, complete with accessory and reduction gearboxes, was conducted on October 28, 2005. The engine was operated in a horizontal and vertical attitude as well as an intermediate position of approximately 30 degrees from the horizontal. As the gearbox lubrication system had yet to be completely defined during these tests, the accessory and reduction gearboxes were filled with an appropriate amount of oil and sealed. Seven cycles and 14 minutes of operation were recorded during this first series of runs with no unexpected problems or oil consumption issues.



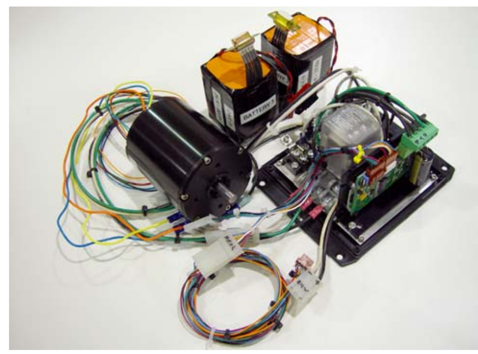
Comprehensive Engine Testing

Operational experience was rapidly gained throughout November with total recorded engine time accumulating to over two hours. Confidence with the engine was such that a comprehensive performance test was conducted by the contractor in mid November. Engine operating parameters including temperatures, core and output RPM, torque, power, fuel consumption, acceleration and acoustic signature were all evaluated. Testing continued unabated to gain additional operational data. At regular intervals, the core engine and each gearbox were completely disassembled and inspected. In general, very little wear or other problems were found. This testing/teardown pattern continues today as the wear characteristics and engine maintenance needs are identified.

Engine Systems Design/Development
Work began in December 2005 on the engine oil, fuel and electrical systems. The goal was to make the engine as self-contained as any larger turbine engine requiring only an outside electrical source for starting. The oil system features pressure lubrication to all main engine bearings and gearboxes. Additional pump sections contain the scavenge system to return oil back to the vehicle mounted oil reservoir. A high-pressure fuel pump and integrated fuel controller provide fuel to the fuel nozzles and enable a wide range of engine speed control. The electrical system centers around the integrated starter/generator which is able to electrically start the engine and then switch into generator mode once the engine is running. An industry standard ignition exciter is all that is necessary to provide the short duration spark required during engine starting. The fuel and oil pumps and the starter/generator are each mounted to the accessory gearbox and are able to be individually removed if necessary.

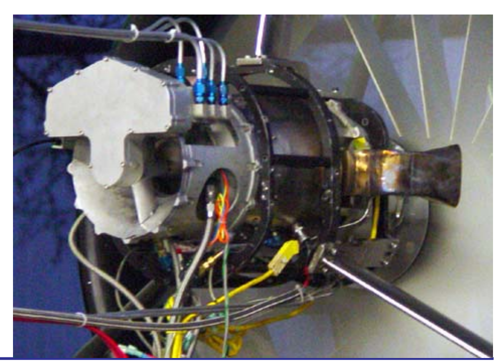


Starter/Generator - Autostart Capabilities
A compact, brushless DC motor and controller was developed to function as the starter/generator. Weighing only 2 pounds, the brushless motor provides for very quick electric starts and is capable of providing 700 Watts of output power when serving as a generator. A complete autostart system was developed in conjunction with the starter/generator that allows the engine to be remotely started with no operator intervention other than the command to start. Once the start command is received, the autostart manages the starter, schedules fuel flow and monitors critical engine parameters. Proven over hundreds of starts, the autostart system provides an exceptionally easy way to manage engine operation.

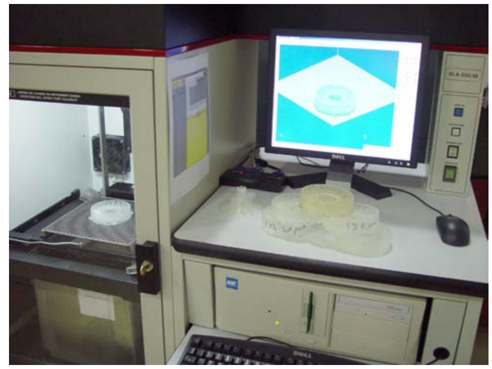


Initial One Hour Endurance Run
Despite hundreds of cycles and many hours of accumulated run time, no long duration runs had been conducted through spring and summer 2006. On September 21, 2006 the engine was started and run at a high power setting for 61 minutes. This test was conducted in conjunction with ongoing fuel and oil pump development to help identify problems associated with long term engine operation, accessory cooling and pump capacity. A post run teardown revealed no engine problems despite limited oil circulation.

Fuel and Oil Pump Development
Work progressed through the summer and fall of 2006 on manufacturing the fuel and oil pumps. Numerous design iterations were required to optimize pressures, flow rates and internal pump seals and passageways. The pumps in their current configuration have been operating for several months and are proving to be more than adequate throughout the complete performance range of the engine.



Capabilities Enhancement - Manufacturing, SLA, New Casting Equipment
TTL continues to invest heavily in new manufacturing technologies to support its development activities. Additional four and five axis machine centers have been added as has high-speed, high-capacity turning equipment. Rapid prototyping equipment including that supporting the sterolithography (SLA) process has been installed. An ongoing internal research and development program is in place to develop vacuum casting methodology utilizing SLA models for the casting investments. High temperature alloy casting capability has been further enhanced through the installation of a high-frequency, solid state induction furnace control system that provides extremely accurate management of the material melt and pour process.



With the experience gained over the past two years of PT-50 engine development and operation, TTL is intent on improving the PT-50, optimizing efficiency and increasing overall engine utility - all changes made with an emphasis on UAV applications. A comprehensive development plan is in place with the goal of accomplishing the following:

- A thorough thermodynamic analysis and review of the PT-50 core to optimize flows, combustion processes and power turbine energy recovery to maximize power output and minimize fuel consumption
- A complete strength to weight analysis on each component to arrive at an acceptable, unified safety factor throughout and to minimize overall engine weight
- Extensive duration testing and component evaluation on the existing PT-50 to allow for 500+ hour engine life on production engines
- Design, development and manufacture of an enhanced PT-50A model incorporating positive improvements from the items above

Next Development Update - April 20, 2007

Scheduled to Include:

1. *Engine Testing Progress*
2. *PT-50A Core Engine Parts Production*
3. *PT-50A Revised Component Testing*
4. *Website Revision*