



SERVICE OVERVIEW

DIGITAL TWIN: MODEL-REFERENCED EQUIPMENT HEALTH MONITORING

**Predictive.
Preventive.
Proactive.**

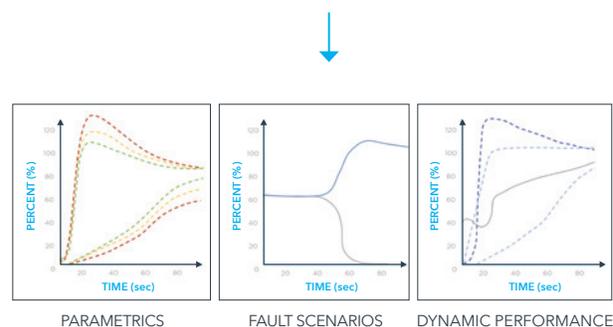
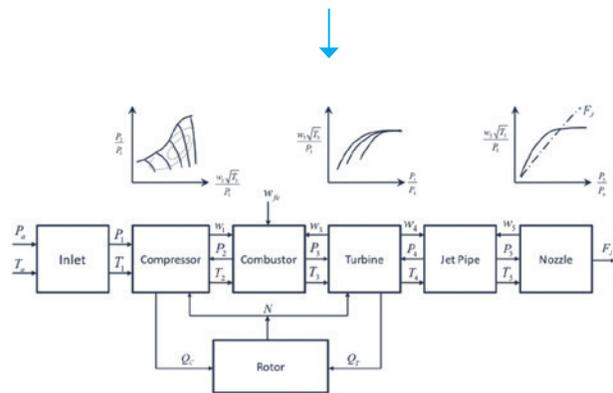
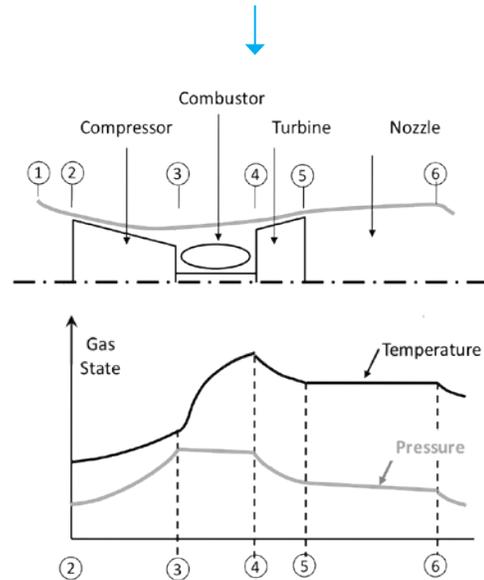
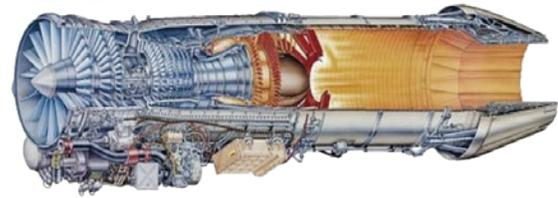
Gastops Propulsion System Simulation and Condition Monitoring Services

Gastops has been developing physics-based models of propulsion systems for over 30 years, pre-dating the dawn of 'Digital Twin'. Our models have been used for system integration, condition monitoring, control system development, and more.

Gastops can develop a digital twin of single engines or entire propulsion systems by combining a deep understanding of engineering principles, systems engineering, control theory, and condition assessment with your unique asset data.

The digital twin can represent your engine as designed, as built, and as maintained. This provides an opportunity to conduct design verification, parametric studies, control optimisation, and enable effective model-referenced Equipment Health Monitoring (EHM).

In a model-referenced EHM application, our physics-based, data-informed functional model digital twin can calculate the expected performance of an engine and be used as a reference point for measured engine behaviour. Deviations between the digital twin and the physical twin are then used as a symptom of engine health and compared against a cause and effect failure mode library to diagnose the root cause of an engine problem.



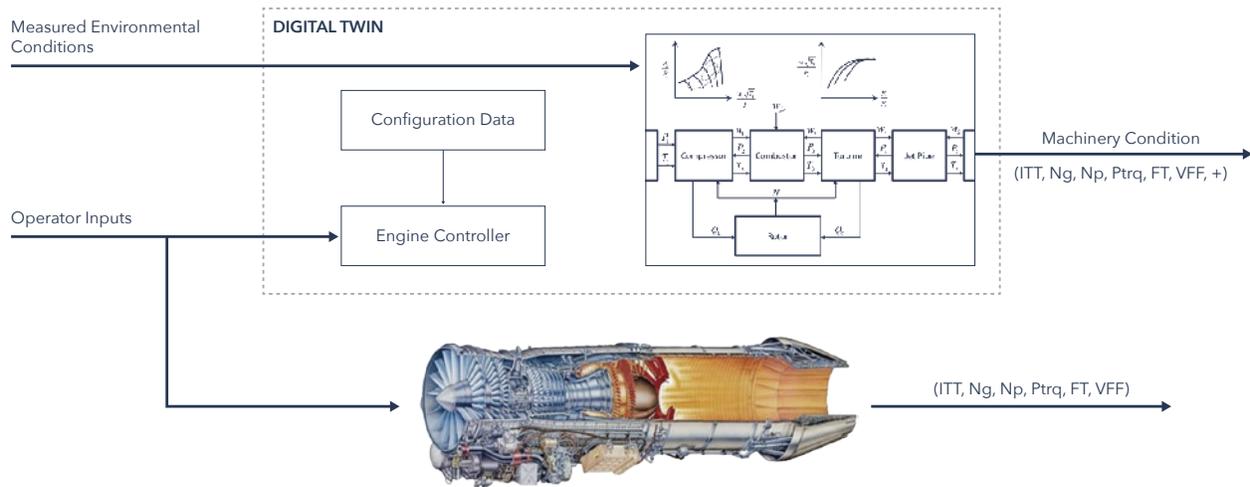
Model-Referenced EHM Overview

Monitor Your Asset with Model-Referenced EHM

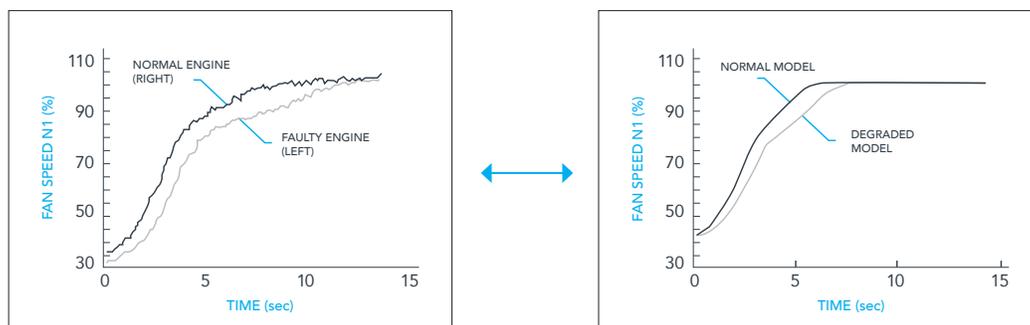
- Run the digital twin with degraded components to establish a custom fault library
- Operate the digital twin in parallel with your asset to identify abnormal behaviours
- Conduct digital parametric studies to evaluate performance due to system variability and tolerances
- Develop reliable condition indicators for high risk failure models



Digital Twin Model-Referenced EHM Concept



Digital Twins Are Validated and Refined Using Real Performance Data



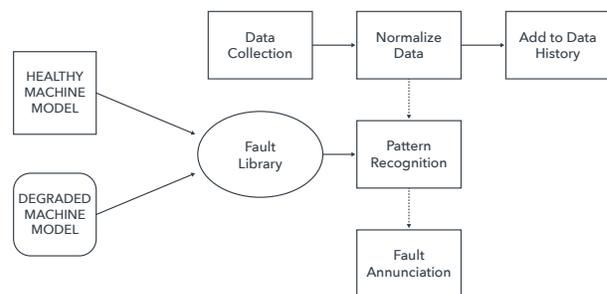
Reduce costs and risk by evaluating your propulsion system performance in a virtual environment ... the Gastops Digital Twin.

Model-Referenced EHM Application

Background

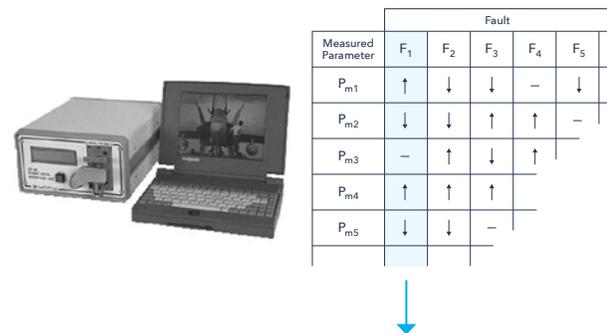
Model-referenced EHM for gas turbine engines was initially developed for the Royal Canadian Air Force (RCAF) to provide effective condition monitoring of the F18 aircraft F404 engine.

Gastops' technology was also provided to the Royal Malaysian Airforce (RMAF) and Royal Australian Airforce (RAAF) for condition-based maintenance for their F18 aircraft fleet.



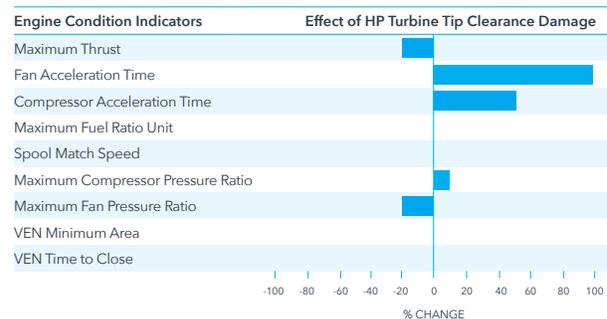
Digital Twin EHM Condition Indicator Identification

Used to simulate expected engine performance for healthy and degraded conditions to relate symptoms of problems observed with component degradations to derive unique condition health indicators.



Digital Twin EHM Condition Indicator Application

Operate the 'diagnostic' engine model to generate results of engine degraded performance to develop a cause and effect library with an interactive expert system capable of identifying component faults for first line maintenance troubleshooting.



Gas Turbine Engine Simulation Expertise

- GE F404 gas turbine
- RR T56 gas turbine
- P&WC PT6 gas turbine
- P&W FT4 gas turbine
- GE LM2500 gas turbine

