

## CASE STUDY

# T55 Engine Life Cycle Model

## Introduction

The T55 turbine engine is used to power the Army's twin engine CH-47 Chinook helicopter. The US Army Logistics Integration Agency (LIA) contracted with Clockwork Solutions to create and utilize predictive models for analyses of life-cycle cost issues related to T55 engine reliability and logistics. A second contract involved a data gathering and assessment project to provide the background data necessary to build and sustain predictive simulation models. The work was conducted in coordination with the US Army Aviation and Missiles Command (AMCOM), PM Cargo Helicopters, and the Integrated Material Management Center.



The main goals of the combined modeling and data assessment projects were to produce results of immediate value to the Army, to provide for the extension of the model as additional data becomes available, and to support the revision of process rules. In addition, the army wanted to develop a framework for the improvement of its information system backbone required for supplying data to equipment/systems life-cycle models and libraries. The SPAR™ models that Clockwork created were targeted to the L712 configuration of the T55 engine.

## SPAR™

SPAR™ is Clockwork Solutions' modeling and simulation technology for predicting system behavior in order to reduce asset ownership cost and increase performance. SPAR™ models are based on statistics and rules that define, at a detailed level, how elements of a system and its support infrastructure behave dynamically in time. By modeling the details of element behavior and the relationships between elements, performance of large, complicated systems can be predicted accurately.

## The T55 Model

Clockwork incorporated data from several sources into a single comprehensive model of the T55 engine. Like other SPAR™ models, this model uses Monte Carlo techniques to simulate the behavior of the engine for a defined duration, automatically generating failure, repair, maintenance, and supply events.

The T55 model represents tradeoffs driven by the goals of the project and by the current availability of data essential to modeling and managing such a complex process. Aircraft, engines, and major assemblies are explicitly represented. Smaller component parts are added as sufficiently detailed information becomes available for reliability modeling.

Aircraft in the model fly according to a flying program determined by the user. Army personnel “operate” the aircraft (run the model) to achieve an equivalent number of flying hours per month per aircraft. For each engine, the model generates failures representing unplanned removals that cause the engine to go to the depot for overhaul or repair. Upon engine failure, the aircraft is grounded until a replacement engine is available from the spares pool or a controlled exchange (CX) is available. Failed engines are tagged as unserviceable and are queued subject to depot induction. Depot induction criteria are classed by program, i.e., minor repair, overhaul, and refurbishment.

The model is an accurate and cost-effective means for evaluating changes in aging processes and changes in repair effectiveness and their effects upon support cost and fleet readiness. The model supplies a set of outputs that are used to compute both costs and benefits from adopting various strategies over a given time interval. Default outputs include:

- Number of unplanned engine removals
- Number of engine inductions for overhaul at the depot
- Counts of various depot actions for each type of assembly
- Number of life limit events for each assembly type
- Number of times that a spare engine is not available when one is needed
- Number of spare engines used
- Number of controlled exchanges of engines
- Readiness levels
- Failure counts per assembly type

Additional output metrics can be formulated easily as needed to address other aspects of performance and cost, or to gain insight into the behavior and status of the various subsystems and the system (engine) as a whole.

## **Data Gathering and Assessment**

The T55 model requires data to define the system and subsystem hierarchical relationships, the rules governing maintenance logistics, the dynamics associated with failure and repair instances, and the current state of the equipment and its support infrastructure at any time. This data is used for development, initializing, and refreshing the model.

Clockwork personnel analyzed the data. Several types of analyses were performed prior to applying statistical procedures in order to check the data’s quality before applying it to the model.

## **Conclusion**

Before Clockwork began work on this project for AMCOM and LIA, the Army had only just begun work on analytical modeling of the life-cycle of the T55 engine. This work was limited due to the general lack of data and because it did not take advantage of Monte Carlo simulation techniques. By utilizing Clockwork’s data analysis capability and SPAR™ forecasting technology, AMCOM now has an enhanced framework for developing and improving upon a realistic T55 life-cycle model. Ongoing applications of this model will continue to enable the US Army to reduce costs and improve readiness associated with the T55 turbine engine.

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